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THE ELECTRIC LIGHT.

ALTHOUGH the possibility of employing the electric light for illuminating purposes is by no means a suggestion of recent date, yet it must strike those who have watched or investigated the progress of electrical science in this direction that very little real way has been made towards rendering electricity a really useful and practical agent for the production of light. It is not that considerable ingenuity has not been exercised in the various attempts made to clear away the difficulties which blocked the way, but simply that these difficulties have not been surmounted.

The production of light by means of the electric current has been attempted in several ways. Some years ago a company was formed for working a process in which water was decomposed by the electric current, the gases so obtained being rendered in some way non-explosive and illuminating by being passed through a hydro-carbon compound. The current for decomposing the water was obtained by means of a magneto-electric machine. Such a process, although it was said to produce illuminating gas at a very small cost, could hardly be an economical way of utilising the electric current, and the scheme fell to the ground, and since that time but few attempts have been made in this direction, the direct utilisation of the current in the form of a spark between two electrodes promising more likelihood of success.

The first difficulty which stood in the way was no doubt the absence of an efficient source of electric power; the galvanic battery did not promise to be at all an economical generator to employ, though for certain purposes, such as the production of light for lectures or theatrical effects, it answered well enough; but now the dynamo-electric machine has attained such a thoroughly practical shape, that difficulty may be said to have ceased to exist. The only points that remained then to be thoroughly worked out have been the form of lamp and also the way in which several lights could be obtained from one source of power, each one being independent of the other.

Considerable ingenuity has been spent in the numerous endeavours to produce a practical and efficient form of lamp; but although lamps have been produced which have answered the purpose of allowing a steady light to be obtained, they have not been such as could come into universal use, supposing the electric current was laid on in the way gas is at present. In all cases they have been worked by mechanism, which was an objectionable feature.

It is a curious fact, which at the present time must be strikingly evident, that all ingenuity has been directed in one groove; the problem which it has been attempted to solve has been that of enabling two carbon rods, placed in the same straight line, with pointed ends close to one another, to preserve the same, or nearly the same, distance apart, whilst they consume under the action of the current. No attempt has been made until quite recently to produce the light between two electrodes except in the manner described; why this has been the case it is difficult to say, but the failure to devise a practical form of lamp up to the present time undoubtedly lies in this undeviating course which has been pursued.

To M. Jablochkoff undoubtedly belongs the credit of having boldly struck out in an entirely new direction, and the success which has attended his efforts has been the reward of his so doing, and is an example to those who persistently follow in the footsteps of others instead of taking a distinct line of their own.

The inventions of M. Jablochkoff have been prominently brought before the English electrical world by Mr. Langdon, the acting secretary of the Society of Telegraph Engineers, in a paper read by him at the last meeting of the society. The paper was an extra one, but the importance of the subject amply justified Mr. Langdon in not deferring it till after the recess.

The difficulties which M. Jablochkoff has overcome, viz., the invention of a simple form of lamp and the method of working several lamps independently on one circuit, so that an accident to, or the extinction of, one lamp might unaffect the others, have really been the chief obstacles in the way, and now that they are overcome, comparatively little stands in the way of an extended adoption of the electric light.

It has almost invariably been the practice, when a new invention is brought forward which possesses striking points of novelty, to prognosticate a splendid future for it, and the revolutionising of the existent means of producing that which the new invention promises to do in a far better manner. Without going so far as this, it is not prophesying too much to say that, with proper management and in proper hands, the invention of M. Jablochkoff will go very far towards proving the entire practicability of the electric light for general lighting purposes; indeed

its adoption by more than one French firm in their workshops has already proved this. That it will supersede gas eventually we can hardly believe; but that it will come into common use is quite possible, in which case a vast opening is given for a new form of industry, and we shall no doubt have as much to do with electric light fitters and engineers as with gasfitters and gas engineers.

As regards cost, there is said to be, and no doubt is, a saving of 50 per cent. over the cost of illumination by ordinary coal gas. This is a large saving, but it is a question well worth consideration—Cannot the cost of ordinary gas be practically reduced by increasing its illuminating power? Is not illumination by electricity after all an indirect way of obtaining light? Coal is burnt to produce motive power, which in turn produces electricity, which is the agent for the production of the light; there is surely a loss in a process like this. That the electric light is cheaper than coal gas in spite of this loss there is no doubt, but that there is such a loss is also equally certain; and although the electric light *may* for a time be a dangerous rival to gas, it in turn must give way to the latter as chemical knowledge progresses.

SYSTEM OF INSULATOR AND SHACKLE TESTING EMPLOYED IN THE TELEGRAPH DEPARTMENT, JAPAN.

By J. RYMER-JONES, late Electrician for the Imperial Government Telegraphs of Japan.

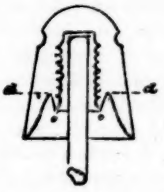
PREVIOUS to February 1874 many of the insulators in use in Japan were of brown earthenware; others of a much lighter coloured clay had a light-green glaze, and were possibly intended for porcelain; but both clays were of exceedingly porous material, and more akin to conductors than insulators, as will be seen from the following results of a few tested :—

No.		ohms.	
1.	Greenish-white insulator	= 757,062	Tested by a Thomson reflecting galvanometer and 1 cell.
2.	„ „ „	= 875,817	
1.	Brown earthenware „	= 4,190,000	
2.	„ „ „	= 76,571	
3.	„ „ „	= 114,530	

With such so-called insulators it is unnecessary to say that the insulation of the lines was exceedingly defective, and on the introduction of the present system of testing, these, together with other white porcelain insulators and shackles which had been put on to the lines without being tested, were taken down and replaced by others which had been subjected to a severe electrical test.

No insulators are now imported as of late years, but all are manufactured by native merchants, and their quality is in most cases excellent. The clay is generally white, fine-grained, compact, thoroughly vitrified throughout the whole substance, and the glaze hard, even, and, so far as can be judged from appearance, likely to be durable. The clay, however, varies considerably from time to time, and a porous, soft clay is sometimes substituted, containing, not unfrequently, a large amount of discoloration, apparently due to the presence of oxide of iron, and often discernible through the glaze in the form of brown blotches. This brown impurity conducts well, and invariably renders insulators worthless. Others again have a crack running round that part of the cup where the bell portion joins the head (fig. 1, *a a*). This crack, in some cases,

FIG. 1.



penetrates nearly the whole way through, and is easily detected by the eye, a slight blow being sufficient to separate the two portions; while in other cases the crack enters but a short distance into the body, and is only to be detected by testing. This crack, it would appear, arises from the unequal contraction by heat, during manufacture, of the thin and thick portions of the cup from an insufficiency of silica in the clay. The form of insulator is that known by the specific term "invert," and is a single cup (fig. 1), the bolts being fixed with a cement composed of sulphur and pumice-stone; and I cannot learn that insulators have suffered from the expansion of the sulphur.

The following is a somewhat detailed description of the system of testing. Insulators to be tested on the following day are thoroughly washed in hot water to remove any grease that may exist on their surfaces, and are then allowed to soak in acidulated water all night—the time of soaking varying from 19 to 24 hours. The testing trough has an internal coating of sheet-lead, and is fitted with a light framework of wood, provided with circular holes, into which the insulators may be conveniently placed for testing. One pole of a battery of 200 cells (Daniell), well insulated, is permanently connected with the lead coating of the trough, and, when testing, another wire connected with the testing apparatus is dipped into each insulator in succession.

The wires leading from the testing-room to the battery and trough rooms are lengths of cable core, suspended for the most part freely in air, or by tarred tape, so as to reduce the leakage to a minimum, and pass through the centres of shackles fitted into the wall, the shackles being always kept clean and dry. The testing table is of solid brickwork, with a wooden top, and is quite detached from the floor. On it are the necessary instruments for measuring the electro-motive force of the battery and the constant of the galvanometer.

The latter instrument is a Thomson reflecting galvanometer, especially adapted for measuring high insulation resistances, the coils having a total resistance of 20,000 ohms. The utmost possible care is taken to secure good insulation where

necessary. The galvanometer stands on a large sheet of ebonite, supported underneath by two blocks of wood, the latter being also insulated from the table by small pieces of ebonite. Every other part of the apparatus, including condenser, resistance coils, reverser, keys, and terminals, is additionally insulated, and every morning, before taking the daily tests, a hot flat-iron wrapped in a dry cloth is passed over the sheets of ebonite, while the smaller pieces and the insulators on which the testing trough and battery stand are thoroughly dried with hot cloths, after which the leakage from the leads, if any, is recorded, and the daily tests taken.

When adjusted to its maximum degree of sensibility the galvanometer was, with 200 cells, capable of measuring 17,000,000 megohms, but for ordinary work this sensibility is considerably reduced, so that a deflection of 1° represents a resistance of 2,000,000 megohms (approximate).

The standard resistance for each cup or shackle is fixed at 40,000 megohms, a resistance considerably below the average, but sufficiently high to insure the material being of good quality, while at the same time the deflection is large enough to allow of rapid testing, since, in consequence of the crucial character of the test, even when the utmost care is taken to dry the edges of the insulators, more or less moisture, varying with the hygrometric state of the atmosphere, accumulates on the edges. Indeed, this is so much felt in the rainy season that it is necessary to test as soon as the insulators are ready, and a smaller number at one time, otherwise, from the excessive accumulation of moisture, the limit of deflection is very soon exceeded; but on drying the edges a second time and testing immediately afterwards many of them are found to be good.

Although it is absolutely necessary to fix upon a standard and rigidly adhere to it, there is little difficulty in recognising the difference between conduction through the body and leakage over the surface of an insulator when testing, unless the air is highly charged with moisture and a long interval allowed to elapse between the drying and testing, since, should the clay be in the least degree defective, the deflection on the galvanometer is very much greater in the former than in the latter case. It was the habit of the writer to keep daily records of the dry and wet bulb thermometer, and also of the temperature of the water in the testing trough, since by this means it was easy to see whether the weather was favourable for insulator testing or not. It is evident that the drier the air the less is the moisture deposited on the edges; but as there are several troughs in the room there is always some moisture in the air. The temperature of the water in the testing trough, moreover, is lowered during the night, and is generally lower than the surrounding air when testing; consequently, when insulators are immersed in the water, they soon take the same temperature, and their cold edges increase the condensation. This condensation is reduced to a minimum by raising the temperature of the testing trough to the same temperature as the air by pouring in a little hot water before beginning the daily testing. When there is a large difference between the dry and wet bulb for ordinary testing this precaution is unnecessary, but in very rainy weather, or when very exact measurements are required, it will be found useful.

The mode of preparing insulators for testing differs from that usually adopted, the edges being thoroughly dried by hot cloths. By this means, not to mention the saving of grease, paraffine, or turpentine, and the difficulty of removing the same after testing, the disadvantages of any such substances coming in contact with that portion of the insulator immersed in water, either from want of care in the application or from the surface of the water becoming covered with a film of the same, and thus artificially increasing the insulating properties of the material, are avoided. The system of drying has been found to answer well in all weathers when proper precautions are taken, and is as follows:—

A large square stove, 4 ft. long × 3 ft. broad × 2 ft. 10 in. high (figs. 2 and 3), constructed of thin sheet-iron, and strengthened by angle iron, is provided in front with two folding-doors reaching

FIG. 2.

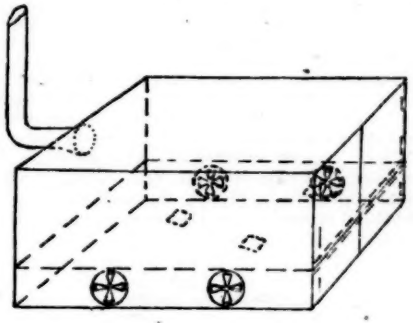


FIG. 3.

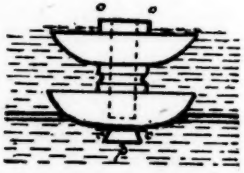
from the top to within 10 in. of the ground. Inside the stove, and on a level with the bottom of these doors, is a tray of sheet-iron, strengthened below by lengths of T iron, and supported by iron ledges on either side. The stove is thus divided into an upper and lower compartment, 2 ft. and 10 in. deep respectively, separated by the tray. Holes are cut in the sheet-iron of the tray, and over these are placed "hibachi," or Japanese charcoal fires, very much resembling large square earthenware crucibles, with a hole in the bottom, covered over with a small grating to prevent the charcoal from falling out. Below the tray are four ventilators, two on either side, and a chimney behind carries off all the carbonic acid from the upper compartment into the air outside. By opening one or more of these ventilators, a varying quantity of

air enters the lower compartment, and passes directly through the fires placed over the holes in the tray. If necessary, the fires can be made to burn brightly in a few minutes by opening all the ventilators and closing the folding-doors in front, or, on the other hand, should the stove become too hot, the closing of the ventilators acts as a damper on the fires, and by opening the doors in front a cool draught of air carries the heated air up the chimney, and thus quickly reduces the temperature of the stove. By opening and closing a ventilator, however, now and then, the heat can be regulated at will. When the fires are low the tray is drawn out in order to put more charcoal on, and as the iron retains its heat for some time no delay is caused in the drying.

The drying cloths are spread over the top, and hang down the sides of the stove, and are always hot and ready for drying the edges of the insulators. The cups and shackles are only taken out of the soaking troughs immediately before drying, and are then held by a moist cloth so as to prevent the surfaces becoming dry or greasy by being held in the hand. When dried the insulators are placed in a rack made to hold twenty, which number should always be kept ready. One assistant places these insulators into the testing trough, so that the water reaches within half-an-inch of the edge outside, while a second, by means of a watering-can with a long tapering spout, pours acidulated water inside each cup to the same height.

When a suitable number of insulators are ready, the testing is proceeded with, each insulator being tested separately, by dipping the leading wire from the testing apparatus into each in succession. With

FIG. 4.



eight Japanese employed in drying the edges, the author has, by this system, tested 300 in an hour and a half, or 100 in thirty minutes.

The day's testing ended, the good insulators are washed to get rid of any acid which may remain on their surfaces, and afterwards the sulphur and top of the cavity (o o, fig. 1), where the bolt enters the insulator, is painted with a reddish-orange oil paint, and without this distinguishing mark no insulator is sent out from the store department. An additional advantage in the marking exists in the fact that the bright colour is easily seen by the superintendent when inspecting the lines.

Shackle testing.—The importance of shackle testing must appear evident when we consider how largely this form of insulator is employed in telegraph construction, and especially in towns; but in consequence of the awkward form the author had considerable difficulty in devising a satisfactory plan of testing, and at length determined to try the effect of vulcanised india-rubber plugs, and was rewarded by finding this simple expedient a complete success.

From a sheet of vulcanised india-rubber about an inch thick, plugs in the form of corks are cut, rather larger than the holes in the shackles, by means of cork-borers and alcohol.

After drying one end of the bolt-hole thoroughly with hot cloths, a hot india-rubber plug P (fig. 4) is tightly screwed into it, to a distance of half-an-inch or more. The other end is then carefully dried both inside and out, and the shackle placed in the testing trough, plug downwards, so that the water reaches within about half-an-inch of the top on the outside, and with the tin-can acidulated water is poured inside to the same height. In other words, as soon as the plug is screwed in, the shackle is tested precisely as a cup. This method was employed by the author for two years, and found to be all that could be desired.

The leakage through the plugs, when the latter had been thoroughly warmed, was not perceptible on the galvanometer.

The portion of the shackle from o o to c c is clearly the most important part to be tested, since, should the clay be conducting, the greatest facility for conduction is through the thinnest portion where the wire encircles the shackle; and as the whole shackle is made of the same clay, should c c, o o test well, the remainder may, with tolerable certainty, be assumed to be good likewise.

That some test was requisite may be judged from the fact that the author has found that the percentage of bad shackles on the whole exceeded the percentage of defective cups, and, in consequence of the varying quality of clay used, the percentage of rejected insulator cups and shackles has sometimes been exceedingly high.

About thirty or forty plugs are sufficient for the testing, and these are placed in a thin wooden box, with a perforated bottom, or in a small shallow basket, and are covered over with a cloth to keep in the heat. The box or basket stands at the back of the stove, care being taken that the heat is not strong enough to injure the india-rubber.

The resistance of some of the white porcelain insulator cups and shackles, when more than usual care was taken in drying, amounted to 3,000,000 megs. after one minute's electrification; in fact, this resistance appears to represent the degree to which the edges had been dried, rather than the true resistance of the material.

In order to test the body as severely as possible, the glaze was ground off the heads of several cups previous to soaking and testing, but this made no appreciable difference in the resistance obtained.

THE ELECTRIC LIGHTING AT THE LA CHAPELLE GOODS STATION OF THE NORTHERN RAILWAY COMPANY, PARIS.

IN consequence of experiments made in 1876 at the Paris Passenger Station of the Northern Railway Company, it was decided that the best place to apply the electric light was at the goods department of the station named, where work was carried on during the whole night long.

As a general rule, the saving effected in the establishment of a system of lighting is the greater the longer the lighting is employed each night. It

was under these favourable conditions that the railway companies wished to place themselves.

The plan originally resolved upon was slightly modified, in consequence of the care taken to profit by any favourable circumstances which presented themselves. In fact, the following was the course adopted :—

There were lighted,

1st. A hall of 70 metres long by 25 metres wide, and 8 metres high.

2nd. A hall 70 metres long by 15 metres wide, and 8 metres high.

3rd. A yard 20 metres square, which separated the hall from the cart-shed.

The hall is lighted by two lamps placed over one of the diagonals, and consequently in an unsymmetrical, but very favourable, manner. The lights are 4½ metres from the ground, in large square lanterns. The glass of these lanterns is painted white inside, and up to such a level that at no part of the hall can the voltaic arc be perceived. The upper part of the glass of the lantern was left in its natural condition, and the bottom is left unglazed; the consequence being that the rays of light shine on the ceiling and walls of the hall, which have been lime-whitened, and reflect a light soft and very uniformly spread.

The lighting of this hall was the principal object in view; it is very abundant, and that is necessary, because there are numerous small parcels amongst the large ones, whose labels it is necessary to be able to read and register upon the arrival and unloading of the packages at different parts of the hall. One can see well everywhere, even in the most distant corners of the space in question, as well as in the little passages between the heaps of bales, and in spite of the shadows cast. One can see even sufficiently in the bottoms of the waggons which are being loaded or unloaded.

The following passage is extracted from a document which has been kindly lent with the authority of M. Sartiaux, the engineer of the works :—

"The lighting has been in daily operation for fifteen hours and a half, on an average, from January 17, 1877. The magnificent light spread in the halls allows work to be done with the utmost facility, the saving of labour effected thereby being estimated at 25 per cent.

"Each foreman does not require to carry a lantern in his hand to look for the packages, decipher the addresses, or seal the labels; the work, in fact, is done as easily as it could be done in the broad daylight.

"Two halls are found to be sufficient for carrying on the work where formerly three were necessary. Beyond all these direct results, the electric lighting has given indirectly the following advantages, which diminish the indemnities paid by the companies : It diminishes the mistakes of direction, and the delays consequent thereon; the damage done in loading. . . . It prevents various kinds of frauds to the senders of the goods, and, in fact, it facilitates surveillance, it diminishes thefts."

The second hall is lighted by a single lamp, and this is sufficient, because large bales only are dealt with here; the lantern is like those in the first hall. The lime-whitening has been experimentally proved to be necessary here as in the other building.

The yard is lighted above by the lamp belonging to the second hall, which is entirely open on the long sides, the light from the first hall also shines in when the doors are open. In fine the lighting is as good as in the streets of Paris.—*Fontaine's "Lighting by Electricity."*

DISTRIBUTION OF THE RADICALS OF ELECTROLYTES UPON AN INSULATED METALLIC CONDUCTOR.*

By ALFRED TRIBE, Lecturer on Chemistry in Dulwich College.

AMONG other facts demonstrated in my communication to the Royal Society in January 1876 (Proc. Roy. Soc. vol. xxiv. p. 308), it was shown that a rigid conductor, when placed lengthwise between the electrodes in a fluid, in the act of electrolysis, becomes, with sufficient battery-power, endowed with the power of doing chemical work similar in kind to the battery-electrodes themselves. This phenomenon, it was contended, was explicable on the view which regards an electrolyte as a dielectric, with the additional function of being capable of mutually exchanging its constituents in the act of depolarisation—a conception which induced the quantitative experiments detailed below.

DISTRIBUTION OF THE POSITIVE RADICAL ON THE END OF AN INSULATED STRIP OF METAL FACING THE POSITIVE ELECTRODE.

For these experiments a 5 per cent. solution of copper sulphate was employed, and a glass trough 30 centimetres long by 13 centimetres broad and 12 centimetres deep. In each experiment a strip of silver plate about the thickness of writing-paper was placed lengthwise, midway between the electrodes, and allowed to remain immersed in the electrolysing fluid for one hour, the battery power being 5 cells of Grove. In experiments 1 and 1*a* the strips were similar, being 1 decimetre long and 1 centimetre wide. In experiment 2 the strips were of the same width, but 4 millims. longer, 2 millims. at each end being covered with varnish, with the object of eliminating the action of the end surfaces. Successive lengths of 2 millims. exactly were cut off after the action, and the copper thereon was determined by the cyanide of potassium and ammonia method. One centimetre of the cyanide solution was equivalent to ·00309 grams. of copper. The results were as under :—

Length of 2 millims. commencing at the end facing the + electrode.	Cubic centimetres of KCy used.		
	1.	1*a*.	2.
1.	7·2	7·3	5·4
2.	5·0	4·4	4·2
3.	4·0	3·6	3·6
4.	3·1	3·1	2·8
5.	2·9	2·4	2·4
6.	2·1	2·3	2·3
7.	1·9	1·8	1·4
8.	1·6	1·4	1·3
9.	1·1	1·2	1·0
10.	0·6	0·5	0·6
11.	trace	0·0	0·0

* Read before the Royal Society.

It is apparent from the numbers that there is a considerable accumulation of the positive radical (and hence it may be concluded of negative electricity) at the extremity of the strip in proximity to the positive electrode, and that this gradually diminishes until, at a distance of 22 millims. from the end, it becomes too small for estimation. The relatively small number in the first line of experiment 2 shows the influence of the end surface.

The subjoined table exhibits the results, showing the distribution upon a diamond-shaped strip (1 decimetre in its longer and 1 centimetre in its shorter diagonal), placed lengthwise under similar conditions :—

Lengths of 2 millims. counting from positive electrode.	Cubic centimetres of KCy used.	
	3.	3a.
1.	2·6	3·1
2.	2·0	1·7
3.	1·4	1·8
4.	1·6	1·7
5.	2·1	1·8
6.	1·9	2·1
7	2·0	1·4
8.	1·7	1·6
9.	1·3	1·3
10.	1·0	1·2
11.	1·0	0·5
12.	0·4	0·0

It is worthy of notice that the positive radical is detectable at a somewhat greater distance from the point of the rhombus than from the end of the rectangular strips.

The area of the first 2 millims. of the rhombus equals 0·4 square millims. Calculating the copper on the first 2 millims. of the rectangular strip for an equal area, the accumulation on these areas is shown to be greater on the rhombus in the ratio of 20 to 1. This illustrates to a considerable extent the power of the more pointed conductor in storing up the radical.

Distribution of the Negative Radical on the End of the Conductor facing the Negative Electrode.

For this a cylinder of pure copper, 1 decimetre long and 1 centimetre in diameter, was placed lengthwise in the trough containing a 5 per cent. solution of copper sulphate, its position being similar to that of the silver strip in the previous experiments. The end of the cylinder, which was so placed as to be eaten away in the experiment, was made up of sections of 3 millims. each screwed together. The first cylinder had six, and the other two twelve, divisions each. The amount of action was found by weighing the sections before and after subjecting the cylinder to the action of the electrolysing fluid.

In experiment 4, three cells of Grove were used, the time being two hours; in experiment 5, five cells for one hour; and in 6, ten cells for one hour.

No. of Section, counting from the end opposite the negative pole.	Weight in grams. of copper dissolved.		
	4.	5.	6.
1.	·0923	·0936	·1590
2.	·0532	·0428	·0982
3.	·0368	·0325	·0745
4.	·0343	·0277	·0568
5.	·0285	·0226	·0507
6.	·0241	·0184	·0464
7.		·0164	·0391
8.		·0138	·0341
9.		·0120	·0271
10.		·0100	·0280
11.		·0084	·0202
12.		·0062	·0168

In experiment 4, signs of corrosion were noticeable to 48 millims. from the end of the cylinder, while the deposit of copper reached 46 millims. from the other end. In experiment 6, corrosion was noticeable also to 48 millims. from the one end, and deposition to 46 millims. from the other end. From this it would appear that the electro-negative radical spreads over a greater surface than does the positive radical, or that the neutral line is not in the middle of the cylinder, but somewhat removed towards the negative end—that is, where the deposition of the positive radical takes place.

The numbers in the columns 1, 1a, and 2 may be taken as showing approximately the distribution of the positive radical or negative electricity on the respective silver strips; and the numbers in 5 and 6, that of the negative radical or positive electricity on the copper cylinders.

A CYLINDER HOLTZ MACHINE.

By Prof. Elihu THOMSON.

The many advantages possessed by induction electric machines over those producing electricity by friction have caused the latter to be almost entirely discarded as a source of static electricity. Of these induction machines the "Holtz" is perhaps the best known, and many modifications have been designed to render it self-charging and constant in action. When, however, the plate form is adopted, the limit to the size of the revolving plates, with the ordinary materials and space that can be allotted, is soon reached. With glass plates, the speed of running is limited by the fragile nature of the glass itself.

The form of Holtz machine presently to be described, it is believed, obviates these and other disadvantages, and affords at once a cheap, compact, and portable piece of electrical apparatus, capable of being run at a very high speed, and greatly increasing the electrical power of the machine.

The materials used in the construction are chiefly paraffined wood, and paper or cardboard, also paraffined. When wood or paper is thoroughly dried or baked, and, while still hot, immersed in melted paraffine at above 100° C. until soaked, it becomes, after cooling, one of the best non-conduc-

tors of electricity known. The wood so treated is very strong, and will not subsequently warp or change its form. It is, so to speak, completely waterproofed.

In the figure, CC is a hollow revolving cylinder of paraffined paper or cardboard, the ends being made of the same material, or of wood similarly prepared. This cylinder is revolved about a *fixed* axis A by the pulley P. The axis A is fixed to the frame of the machine at B, and is made of paraffined wood or other insulating material. It serves as a support for the stationary inner cylinder MM, also of paraffined cardboard. The cylinder MM carries on its inner surface one or more pairs of what are commonly known as sectors or inductors ss^1, consisting of strips of partially conducting material, placed opposite the outside rows of collecting points RR^1, and provided with the usual pointed projections turned towards the inner surface of the revolving cylinder CC. Parts of the inner cylinder MM adjacent to the sectors ss^1 are cut away in a direction from ss^1 opposite to the direction of rotation of the outer cylinder. These open spaces are seen at WW. The open spaces or windows WW are not necessary if the contour of the inner cylinder be that shown by dotted lines *ff*. The supports for the various parts as above described are all thoroughly paraffined to insure complete insulation. The metallic collecting points or combs RR^1 constitute the conductors or poles of the machine, + and — respectively, or the reverse, the polarity depending on the original charge given to the machine. The charging is accomplished by holding an electrified body, such as a rubbed piece of caoutchouc or vulcanite, opposite one of the spaces or windows W at the same time that the cylinder CC is in motion in the direction shown by the arrow.

The machine may be made self-charging by providing a small accessory cylinder, revolving on an axis parallel to that of CC. The accessory cylinder is made of hard rubber, shellac, sulphur, or the like, and is constantly rubbed by an amalgamated cushion, as in the common frictional machine.

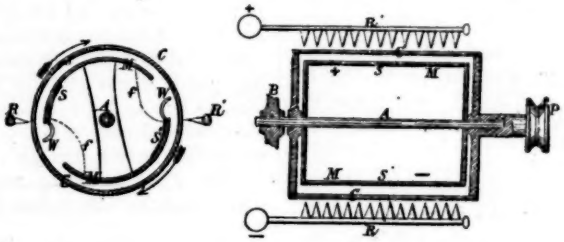
A machine constructed as above, with the cylinder about 7 inches diameter and 12 inches long, and run at a moderate speed, gives enough electricity to charge three one-gallon Leyden jars to a tension of 1 inch in less than four seconds, and may be employed for every purpose where an abundance of static electricity is required.

With a cylinder of 2 feet diameter and 3 feet in length, it is possible to employ at least four rows of collecting points, each of which will be 30 inches long. A single revolving plate accommodating an equal length of collecting points would require to be at least 7 feet in diameter. It is evident that the cylinder may be extended in length without adding seriously to its inconvenience.

The form of machine above described may be modified by placing the fixed cylinder and the sectors outside the revolving cylinder, the collecting points being inside the latter, and the conductors carried out at the extremities of the axis, but such an arrangement of parts possesses, it is thought, no peculiar advantages.

A machine constructed of revolving discs of paraffined paper or cardboard, instead of the ordinary plate, has been tried by the writer and was found to give excellent results. It would be quite possible to mount upon one axis a considerable number, say 50 plates or discs of cardboard properly prepared, which, with their corresponding *sectors* and collecting points, would furnish a machine of this character which, for power, has never been equalled or even approached.

It may perhaps be interesting to remark that, since in the machine described there is a direct conversion of mechanical energy into electric potential, if electricity be supplied to the machine, the cylinder, if sufficiently free to move, at once begins to turn in a contrary direction to that in which it would produce electricity.—*The Polytechnic Review.*



Notes.

THE Postmaster-General has directed Mr. Graves to act as Engineer-in-Chief of the Postal Telegraphs until the retirement of Mr. Culley admits of the former gentleman being permanently appointed to that office. His lordship has further promoted Mr. Winter, now Assistant Engineer-in-Chief, to the newly constituted office of Controller of Stores.

PROFESSOR LOOMIS, of Washington, who has closely studied electrical phenomena, claims to have communicated with an assistant twelve miles away, by means of an aërial current. The current was reached by flying kites a certain height at each point, the string used being a copper wire. When both kites had attained high altitudes, messages were sent and received at the distance mentioned by an instrument at the ground end of the wire, the only electro-motor being the atmospheric current between the kites.

IT has been announced that a new Cable Company was in course of formation for the laying of a cable between the United States and France, by way of the Azores. This announcement is, to say the least, premature, inasmuch as the Portuguese Government has *not* granted any authorisation, notwithstanding the many and repeated efforts which have been made to it towards this object. Even should the Government of Portugal grant it, a geological survey would not be amiss. Promoters might discover certain natural disadvantages that these islands offer to a successful cable enterprise, but it is *so* hard to make promoters see anything disadvantageous in any of their schemes. They reserve that for their shareholders.

IN a note on "Telegraphic Electro-magnets" *(Journal Télégraphique)* M. Lacome brings forward some experiments to show that with equality of resistance it is preferable, with regard to velocity of transmission, that the relays be joined up for quantity instead of for intensity, as is generally the case. He finds the explanation of this phenomenon in the diminution of the induction current, which is weakest when the coils are joined up for quantity. M. Lacome has no doubt brought forward these results in ignorance of the fact that the point had been very thoroughly worked out by Mr. W. H. Preece, in his paper on "Shunts," read before the Society of Telegraph Engineers on February 14, 1877.

THE gross number of cable messages forwarded by all the Australian colonies in 1876 was 2,983, while 3,386 were received; the whole number transmitted was—owing to interruptions to the communication—3,340 less than in 1875. The value of the received traffic in 1876 was £36,978; and that of the forwarded traffic, £38,418. The Penang and Madras cable was interrupted from March 28th to November 30th, while the Port Darwin and Banjoewangie cable was silent from April 24th to August 6th.

THE telegraph line which has been in course of construction through the Bholan Pass is now finished, and a telegraph station has been opened at Quetta.

FOR the electric light, M. Th. du Moncel forms the points of a compressed mass of carbon and magnesia, which is very hard, and burns without ash, giving a light which is steadier and 34 per cent. more intense than is obtained with points formed of gas carbon alone.

THE introduction of compound telegraph wire into general use has been retarded hitherto by the liability of the copper to separate from the steel core, and its largely increased cost over iron wire of equivalent conductivity. By the old process the steel wire core was covered by a thin strip or ribbon of copper, which was drawn spirally upon it by machines specially adapted to the purpose. Within the past two or three years it having become evident that some different mode of manufacture must be found, experiments have been actively prosecuted at the works of Messrs. Wallace & Sons, at Ansonia, Connecticut, U.S., which have been successful, and the wire is now prepared exclusively by electro-magnetic deposition of copper upon the steel wire core. Immense tanks have been constructed in which large quantities of copper can be speedily deposited, and a copper coating of any desired thickness can be obtained upon the wire. By this process the steel and wire are more intimately united, and the danger of separation removed.

MR. P. GADBAN, the Ottoman Consul-General, writes to the *Times:* "Telegraphic despatches have been received from the Imperial Ottoman Ministry of Foreign Affairs and the Ministry of Telegraphs and Posts, Constantinople, pointing out that, although the telegraph line to India through Russia has been interrupted at Soukoum-Kaleh, the Turkish line to India is in perfect order. I shall, therefore, feel obliged if you will kindly make the above fact known through your columns, in the interest of that portion of the public which may be communicating telegraphically with India."

A RECENT number of the *Memorial de Ingenieros*, of Madrid, a scientific military review, established by the Spanish engineers, gives an account of the application of the "Mance Heliograph" to the establishment of telegraphic communication across the Straits of Gibraltar, between Algeciras and Ceuta, a distance of 17 miles. About thirty-eight telegrams have been sent. The rate of transmission being one-half of that obtained by the Morse manipulator, as great care is required to adapt the mirror to the apparent diurnal motion of the sun. "The Heliograph," adds the *Memorial*, "together with another being constructed for night-signalling and cloudy days, will probably constitute a complete and superior system of optical telegraphy, which might well supersede electric cables across the Straits of Gibraltar, which are found so difficult to maintain."

PRIVATE telegraphic correspondence in the interior of Turkey in Europe is only permitted when conducted in the Turkish language.

City Notes.

Old Broad Street, May 28, 1877.

IN common with everybody else we have for some time been expecting to learn the details of the agreement, "on the basis of a joint purse," which has been concluded between the Anglo-American and Direct Cable Companies. It would be absurd to suppose that the "respective proprietaries" to whom the agreement must, as a matter of form, be submitted, will offer any successful resistance to the proposals which Mr. Pender has already taken care will be substantially acquiesced in. There may, no doubt, be protests entered; we trust there will, and that the dissenters from the "joint purse" scheme will avail themselves of the last opportunity which may be afforded them of denouncing the amalgamation policy and all who are responsible for its adoption. But any such protests will, of course, be made in vain. Mr. Pender is too wary to attempt to obtain the assent of the Direct Company to an obviously unfair agreement. To a gentleman who can make crooked places straight and rough places plain it is only a child's task to draw up the terms of an agreement which, by its very plausibility, will secure approbation. We notice the *Telegraph* understands the terms will "give ample satisfaction to the respective proprietaries." But how long will the "ample satisfaction" last?

We have heard nothing more of the proposed testimonial to the founder of the Globe Trust. Does it hang fire? There surely cannot be any difficulty about subscriptions. It would be worth somebody's while to send a cheque anonymously for a thousand pounds—a public testimonial raises a man's character so in the eyes of the public. Or perhaps the testimonial will be given after the knot which fastens the two cable companies together has been firmly tied.

Nothing authoritative can be said respecting the scheme understood to be on foot for the establishment of a Franco-American cable. There are, undoubtedly, difficulties in the way, and they may be found insurmountable. Nevertheless, the day of Mr. Pender's dismay is only postponed. Did we say Mr. Pender's dismay? We mean that of the shareholders who were not proof against the blandishments of the gentleman whose services to telegraphy have, thus far, been so grossly under-estimated.

We hope that certain persons who seize any and every opportunity of letting the world know that business is prospering with the West India and Panama Company will now direct their attention to some investment that stands in need of recommendation. There is never any purpose answered by puffing sound investments, and the statement made by Mr. Earle at the extraordinary general meeting the other day renders puffing, in the case of the West India and Panama, more than superfluous. The figures really speak for themselves.

We should be glad of a little further information from the directors of the West Coast of America Telegraph Company. It is encouraging to learn that they have "contracted for the building of a steamship suitable for the repair of the cables, and for carrying water from one port to another on the West Coast." But why do they not state the terms of the contract? In the balance-sheet there are also two items which seem to call for explanation. To whom have the directors lent £4,000? And how is it that "sundry debtors" owe more than £4,500, or a third of the balance carried to the credit of profit and loss? We do not insinuate that the full amount will not be realised; but it appears unreasonably large. Moreover, it is high time that "the depression in business throughout Peru" ceased to be urged as an excuse for loss of traffic. There has been "depression in business throughout Peru," we had almost said, ever since we can remember. But we like to see reports perfectly straightforward, and we are decidedly surprised that, at the half-yearly meeting of shareholders, the report and accounts were passed "unanimously." Easy-going shareholders! Fortunate directors!

We do not know that the shareholders of the German Union Telegraph and Trust Company have any reason to be dissatisfied with the report which has recently been submitted to them. The total receipts for the year, including £12 brought forward, were £11,613. On the whole we do not think the working expenses, which amounted to £493, are at all out of proportion. It is true the dividend is reduced; but the reduction is solely attributable to the fact that the amount placed in reserve for the renewal of plant has been increased—a commendable piece of forethought. We believe it is perfectly correct that the company's lines have worked well throughout the year, nor has there been any alteration in the speed of transmission.

We have received a copy of a paper styled *The Fortnightly Stock Exchange Review*, which, on looking over, we find is only a trade circular issued periodically by a firm of stock-brokers in Throgmorton Street. We deprecate the multiplication of these circulars; they are generally published in order to puff stock of some kind or other, for which there is *not* a ready sale.

A contemporary has, we notice, been seized with the spirit of prophecy, and, nearly two months before they can be declared, publishes a long list of railway dividends. It is true the precaution is taken of calling them "Dividend Estimates," but it is manifestly ridiculous to indulge in such speculations, and we warn our readers not to place the least faith in them. Events move rapidly, and something may happen between May and the end of June which may altogether alter the prospects even of a railway company, and increase or lessen the dividend accordingly. The guesses of our contemporary may be safe enough, for certain results in certain cases are obvious to everybody; but that does not alter the fact that they are guesses, and therefore worthless.

It has been suggested that there is a possibility the Great Northern and Great Eastern Boards may not, after all, come to terms. This suggestion has been followed by the question, "Would it be wise in the Boards to strike in 1877 rigid permanent terms of amalgamation?" And it is asked whether something else could not be done that would practically unite the companies, "without blending the properties and fixing for ever their relative values—values which must be to a considerable extent estimates." "Could not a working alliance be formed, to be followed by amalgamation, when time had clearly developed the respective values of the two properties?" The printing is the printing of *Herapath*, but the writing looks like the writing of an interested holder in Great Eastern stock. We have always believed in the amalgamation of the two companies, because we think it might promote the interests of both, as well as of the public. But any attempt on the part of the Great Eastern to make a "temporary alliance" should be resisted by the Great Northern Company. When the directors of the Great Eastern had made good their position they might kick over the ladder by means of which they had risen.

Great Eastern shareholders should not quietly pay that little bill of something over £20,000 to the Victoria Graving Dock Company. We can believe that the Great Eastern boats require a good deal of repairing but £20,000 is a big sum. It is a coincidence that one

Lord Hamilton is vice-chairman of the Great Eastern, and another Lord Hamilton chairman of the Victoria Graving Dock Company. It has been said "commissions" absorbed a large amount. Full particulars ought to be forthcoming.

We are not surprised that Metropolitan District stock is in request. The arrangement which the District Company has concluded with the South-Western cannot fail to affect the former favourably. It is certain that numbers of persons will find it convenient to travel direct without change of carriage from the Mansion House to Richmond. The District Company has always been well managed, and its progress, if slow, has been steady. It is probable we shall not hear of amalgamation between the two metropolitan companies again just at present.

Proceedings of Societies.

PHYSICAL SOCIETY—MAY 12, 1877.

Professor G. C. FOSTER, President, in the chair.

THE following candidates were elected members of the Society: Capt. R. Y. Armstrong, R.E., Mr. W. H. M. Christie, Lieut. N. Darwin, R.E., Prof. E. Frankland, D.C.L., F.R.S., Mr. H. F. Morley, Capt. R. G. Scott, R.E., and Mr. Angus Weiss.

Mr. S. P. THOMPSON read a paper on the chromatic aberration of the eye in relation to the perception of distance. He discussed the various means of estimating distances by the eye, showing that when data for forming a judgment by the associations of visible form or visible magnitude fail, the judgment is founded on "aerial perspective," or else upon the muscular sensation of adjustment to focus. As the eye is, however, not achromatic, it cannot be in focus at the same time for red rays and blue rays proceeding from one object, but may be in focus if the blue rays come from a more remote object. This gives a definite basis to the axiom of painters that blue is a retiring and red an advancing colour. Experiments were described demonstrating the truth of this fact, and illustration was afforded of the chromatic aberration of the eye by casting beams of light through a solution of permanganate of potash upon a silvered ball, the illuminated point appearing red with a blue surrounding halo to an eye adjusted to short focus, but blue with a red halo to long focus.

Prof. GUTHRIE referred to the theory by which the apparent size of an object depends on the amount of nervous excitement which it occasions, whether this be due to the extent of the illuminated area or the intensity of its illumination, and he pointed out that an object always appears larger when looked at with two eyes than with one.

Mr. ROBERTS drew attention to the importance of the position of shadows in judging the shape of the objects which project them, and stated that the system ordinarily adopted in mechanical drawing of assuming the light to fall from the left-hand top corner gives an appearance of solidity, whereas, if this be reversed, and the light falls from the right-hand bottom corner, the object appears hollow.

The PRESIDENT referred to the well-known fact that if two stereoscopic pictures are taken representing the same object in complementary colours, most people have a great difficulty in combining them so as to see a single picture of a neutral tint.

Mr. S. P. THOMPSON then described a curious observation of change of pitch occurring when a tuning-fork is caused to rotate rapidly round its axis; the normal interferences at each quarter rotation ceasing to be separately heard when recurring more than about thirty times a second. He has attempted various ways of estimating the amount of this change of pitch, including a method founded on the binaural estimation of interference beats.

Correspondence.

Paris, May 12, 1877.
69, Avenue Wagram.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—An article in your journal has been communicated to me in which you give the description of a thermo-electric pile invented by Messrs. Wray, and assert its superiority over the better-known pile of M. Clamond, I dare to hope that in justice and impartiality you will insert my present reply, which has for its object to refute a most unjustifiable allegation.

You will perhaps the more readily accede to my request, inasmuch as my reply is written in a manner to interest your readers in certain details of thermo-electricity.

Any one acquainted with my thermo-electric pile will acknowledge at the first glance at your illustration that the general disposition and system of heating employed by Messrs. Wray are borrowed from my apparatus. Hence I propose to examine if the so-called improvements of Messrs. Wray are real, or, in other words, if they have improved my apparatus or have only made a bad copy of it.

I will follow the same order as the article to which I reply, and commence to examine the bar itself, of which you give the description.

Generally speaking, the making of the two poles of laminæ cast into the bar is to return to the primitive process employed by the first makers of thermo-electric bars, and of which process I have by experience ascertained the inefficiency, and as for giving the appendix the form of a dovetail that certainly does not constitute an originality, for one could shape the laminæ in an infinite variety of ways with the same object.

According to one paragraph "the elongation of the tongue which forms so distinct a feature in the casting of the bar. The effect of it is to raise very materially the breaking strain, and so get rid of the liability to fracture, to lower the internal resistance, and, strange to say, to increase the electro-motive force."

I must here give some details bearing on this subject.

The resistance of the alloy, antimony and zinc (antimony 806, zinc 406), is about 4,500 microhms at the ordinary temperature of the air, between the two opposite faces of a cubic centimetre. This is doubled and becomes 8,000 microhms when the alloy in the form of a bar is heated in a thermo-pile. The resistance of a thermo-electric bar of this alloy is calculated therefore by the formula $R = \frac{9{,}000 \times s}{l}$, s being the sectional area in centimetres, and l the distance in centimetres between the positive and negative poles.

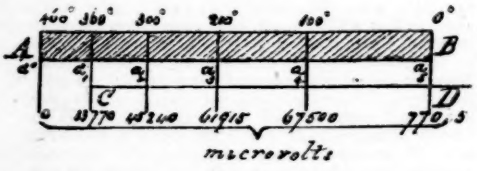
The intensity of the current produced is given by the formula $I = \frac{E \times s}{9{,}000 \times l}$. The energy of the current being proportional to $\frac{s}{l}$, it appears to be advantageous to shorten the bar and increase its section, but this can only be done within certain limits, because the difference of temperature, and consequently the electro-

motive force, diminishes with the diminution in the distance apart of the polar laminæ.

Let A B be a bar of the 3 antimony alloy of which the extremity A is heated to 460° C., while the other extremity B is maintained at 0° C. Let us suppose that metallic condensers in iron or copper A_0, A_1, A_2, A_3, A_4, A_5, be soldered to the bar A B, at such points that the figures written above them represent the respective temperatures at those points in degrees C. The figures written below will indicate in microvolts the electro-motive forces of each of the condensers A_1, A_2, A_3, A_4, A_5, with the conductor A_0, at the most heated end.

An inspection of the above figure will show that the determination of the length of a bar depends upon its section, and that it is necessary to find that dimension which, while giving a high electro-motive force, does not too much reduce the volume of effective current by increasing the resistance. Thus, in one model of my bars I have made the ratio $\frac{s}{l} = 1$, and preserved an electromotive force of 50,000 microvolts—one extremity being below 100° Cent., and the other heated below 400°.

By uniting all the conductors A_1, A_2, A_3, A_4, A_5, by a conductor C D, the electro-motive force developed



between A_0 and D will be the same as between A_0 and A_1 and all that portion of the bar comprised between A_1 and A_5 will become useless. If now we place in the centre of the bar A B an "elongated tongue," reaching from B to A, it will produce the same effect as the conductor C D. The electro-motive force will correspond with that developed between the two points A_0 and A_1, and all that portion of the metal of the bar surrounding the tongue will become useless.

There will be at the same time a decrease in the electro-motive force.

What is most curious in this matter is that the Messrs. Wray have themselves provided the data for the refutation of their own statements. At the *soirée* of the Royal Society of the 29th April they exhibited a pile of 150 bars, having an electro-motive force of 5 volts; 30 of their bars are therefore necessary to produce a tension equal to 1 volt. The electro-motive force of their bars is therefore 33,333 microvolts. If this result be compared with the figures of the drawing above and with my remarks on the subject, it will be seen that it is one-third weaker than the force which I mention as easily realised in practice—viz. 50,000 microvolts. This demonstrates conclusively that the statement that the "elongated tongue, strange to say, increased the electro-motive force" is incorrect.

But here is that which is the most curious (I quote Messrs. Wray themselves),—"No. 5 is a pile of 60 pairs, built entirely of broken bars, to demonstrate the great value of the elongated tongue of positives in maintaining a perfect continuity of the electric current, should one or more of the bars become broken from any cause. This pile still gives a good current, although every bar is cracked, and many of them have large pieces chipped out of them."

No better or more satisfactory proof could be devised, to show that the metal which surrounds the "elongated tongue" is useless, than this which shows that the current is produced and flows when the alloy is absent; and if the metal which envelops the "elongated tongue" is useless, the elongated tongue, instead of being a prolongation of the positive pole inside the bar, is only a prolongation outside the effective portion of the bar, and Messrs. Wray's improvement is like carrying *vid* Glasgow a line intended for direct communication between London and Liverpool.

I will now review the general arrangement of the pile of these gentlemen.

1. "The earthenware heating chamber."—I will only say that Messrs. Wray, when they lodged their provisional specification on the 6th of May, 1876, should have abstained from making any claim on this subject, because they must have known that I have constructed piles furnished with a heating chamber either in iron or earthenware since June, 1875, which have been supplied to the public and various manufacturers, and if there should be the least doubt on this subject I can furnish the most conclusive evidence of the fact from most trustworthy sources.

2. "The insulating annular discs supported on projecting blocks."—No great effort of imagination was necessary in this case on this subject, for discs provided with projecting blocks are included in the first patent taken out by myself and partner, Mr. Muir, eight years ago. If I have not employed them it is because I have ascertained that the projecting blocks occupy uselessly space which can be more advantageously filled by bars. The weight of the superincumbent bars does not offer the slightest inconvenience.

3. "The heating system."—The heating system is simply a reproduction, I may say an infringement, of my own. It is for this reason, perhaps, that these gentlemen call it "an ordinary Bunsen burner."

It now remains to examine two other pretended improvements.

The wire gauze placed in the interior of the terra cotta pipe, in order to prevent the striking down of the flame.—The employment of wire gauze is well known, but everybody knows that it only acts by cooling the flame passing through it, and that it loses this property when red hot; when the burner in which it is concentrically placed becomes red hot it will become red-hot also, and would not in that state prevent the "striking down" of the flame if, the pile being alight, the elastic tube conveying the gas were accidentally pressed or trodden upon. Moreover, the mixture of air and gas passing through a wire gauze red hot would rapidly destroy it. The fact is, to employ wire gauze it should be placed somewhere in the flow of the gas which is not heated; but there is nothing to invent, it is only necessary to choose and adopt from the arrangements which already exist.

Lastly, as to the regulator for the admission of air. In a thermo-electric pile intended for serious work, the volume of gas burnt, and the volume of air necessary for the combustion of this gas should be invariable, and consequently the orifice for the admission of air should also be invariable, and not depend in any measure upon a workman.

Permit me to reproduce the conclusion of your article, and my own conclusions thereon.—"We forbear entering into comparison of this with other forms of thermo-piles previously in existence, for any attempt at a comparison would speedily resolve itself into an enumeration of the advantages which Messrs. Wray's form undoubtedly possesses over every other."

I beg to reply that—

1. The form of the pile of Messrs. Wray is nothing but my own.

2. The disposition of the bar is against all the known and admitted laws, and only proves their inexperience.

3. The other pretended improvements do not even belong to them, and are but compilations from that which already existed, and the method of heating is an infringement of my patents.

Agreez, Monsieur,
(Signed) C. CLAMOND.

[WE do not hold ourselves responsible for any opinions expressed by our correspondents.—ED. TELEGRAPHIC JOURNAL.]

Electrical Science in Foreign Journals.

COMPTES RENDUS OF PARIS ACADEMY.

No. 8: 19TH FEBRUARY.

On the Manufacture of Carbon Conductors for the Electric Light. By M. CARRE. A *resume* of researches published some time since.

Action of Electrolytic Oxygen on Glycol. By M. RENARD.

On the Discharge of the Torpedo, Studied by Means of Lippmann's Electrometer. By M. MAREY.

THE dorsal face corresponds to the positive pole of the electric apparatus (as Matteucci said). The currents induced by the torpedo in an induction coil are inverse. If the discharge of a very much weakened torpedo be sent into the electrometer, the mercury column goes in the positive direction with a jerky motion, progressing always more than it retires, till a point is reached, at which the end of the column vibrates without advancing. There is, then, a partial addition of successive flows of electricity, each of which has not entirely ceased when the next comes. This is in striking analogy with the phenomena in contraction of muscle.

No. 11: 12TH MARCH.

On the Electrotonic State in the case of Unipolar Excitation of Nerves. By MM. MORAT and TOUSSAINT.

ADOPTING Du Bois Reymond's conclusion that the variation is positive when the electrotonising current is in the same direction as the current proper, and negative, when it is in the inverse direction, the authors interpret the phenomena thus: From the point where the electrode is applied to the nerve, the battery current is diffused in all directions; of these there are two in which it follows the course of the nerve itself, becoming very quickly weaker from the point of application. When the positive pole is on the nerve the current is divergent; from the middle of the nerve it goes towards the two extremities; it is, then, in the two ends, of contrary direction to the proper current, which it weakens; whence the negative phase of the electrotonic state. If the negative pole is on the nerve, the battery current converges towards the middle; it is of the same direction as the proper current, which it augments (positive phase of electrotonic state).

POGGENDORFF'S ANNALEN DER PHYSIK UND CHEMIE.

No. 11: 1876.

Investigation of the Heat Phenomena in the Galvanic Battery, and of Electro-motive Forces. By M. EDLUND.

IT has been inferred from experiment that the quantity of heat arising from passage of a current through a circuit (including battery) is equivalent to that produced in the battery itself through chemical processes in the same time; supposing the current to do no external work (of induction, chemical decomposition, &c.), and that the processes referred to are primary, and directly connected with the production of current. Call these galvanic heat and chemical heat respectively. If they are equal, it may be said that the whole action of the current merely consists in carrying about the chemical heat to all parts of the circuit, and depositing at each part so much heat as corresponds to the resistance there (though such a process is difficult to conceive). If, on measurement, the chemical heat is found in excess of the other, this is inferred to be due to secondary chemical processes in the battery that have no connection with production of current. If a voltameter be inserted in the circuit, it is said that not all the primary chemical heat arising in the battery passes into galvanic heat, but a portion is used in doing the mechanical work required for producing polarisation and decomposition; the chemical heat for this end being brought by the current into the voltameter. The heat production in this must be equal to that in passage of the current through a metallic conductor with resistance equal to that of the liquid. If the heat in the voltameter be found, on measurement, greater than the galvanic, this is thought due to secondary chemical processes there, unconnected with the current. M. Edlund gives a different representation, which is this: When the current does no external work its entire action consists in calling forth heat in the conductor through which it passes. After it has ceased, one finds no other products of the battery action than the chemical changes in the battery, and the heat which has arisen, partly in the battery, partly in the external circuit. But evidently this heat must be just as great as that which would have arisen from the same chemical changes had there been no current; otherwise we should have either chemical work or heat from nothing. Thus the current has generated no heat at all. In order, however, to overcome galvanic resistance, it does a certain mechanical work, and this passes into heat. Thus the current occasions in the circuit an actual production of heat. But because the whole heat production of the current is *nil*, this can only occur through a consumption of heat occurring at some part of the circuit; which part can be no other than that where the electromotive force has its seat. Thus we come to the result that the electro-motive force, to produce the current, consumes a quantity of heat which is equivalent to the galvanic heat quantity produced by the current in the circuit in overcoming galvanic resistance. These two views lead to different results. According to the one the primary chemical heat quantity is equal to the galvanic heat quantity, so that the former affords a measure of the electro-motive force; according to the other the two heat quantities may be different, so that this measure is not afforded, &c. M. Edlund examines the experiments made by Favre and others in studying the heat phenomena of the battery and current, so as to compare the two views.

Electromagnetic Properties of Unclosed Electrical Currents. By M. SCHILLER.

THE conclusion come to (in the following number) is that no unclosed currents really exist, and that dielectric polarisation possesses electro-magnetic properties.

On M. Schlosser's Reply and the Pretended Superiority of Ebonite for the Discs of Influence-Machines. By M. HOLTZ.

M. BORCHARDT and M. Bleekrode agree that ebonite discs are somewhat more easily excited, and retain the electric state longer than glass ones. M. Bleekrode thinks, however, that the ebonite mass is in general as active as glass, that it can be heated without injury, and that the gradual decrease of its action is inconsiderable. This M. Borchardt disputes, and M. Holtz sides with him. M. Holtz adds as another reason for not giving up glass, the opaqueness of the ebonite, which makes the relations of the working parts less easily inspected and explanation in schools more troublesome. He further states that Poggendorff, Grüel, Ruhmkorff, Riess, and Kundt had discarded ebonite.